STATE MEDICAL AND PHARMACEUTICAL UNIVERSITY
NICOLAE TESTEMITANU

EPIDEMIOLOGY DEPARTMENT

Angela PARASCHIV

THE SYSTEM OF ANTIEPIDEMIC MEASURES DISINFECTION, STERILIZATION, DERATIZATION AND DEZINSECTION

Methodical guide for medical students

CHISINAU
2012

STATE MEDICAL AND PHARMACEUTICAL UNIVERSITY
NICOLAE TESTEMITANU

EPIDEMIOLOGY DEPARTMENT

Angela PARASCHIV

THE SYSTEM OF ANTIEPIDEMIC MEASURES DISINFECTION, STERILIZATION, DERATIZATION AND DEZINSECTION

Methodical guide for medical students

CHISINAU
Editorial-Polygraphic Center *Medicina*
2012

CZU 616.9-084(076.5)
P 33

Approved by the Central Methodical Council
SMPhU *Nicolae Testemitanu* under Nr. 5 of 04.2012

Author: *Paraschiv Angela* – deputy head of Epidemiology Department, Doctor in medicine, associate professor.

Reviewers: *Prisacari Viorel* – doctor habilitat in Medicine University Professor, Emeritus Man, Chief of Epidemiology Department.

Buraciov Svetlana – doctor in medicine, coordinator scientific researcher. Scientific laboratory „Hospital Infections"

This guide is written according to analytical program in Epidemiology for medical students from General and Dentistry faculty. It is contains basic knowledge that has to know medical student about the system of anti-epidemic measures at the contemporary stage. An important issue is practical assignments where students will be able to solve real situation with infectious diseases. Each topic has questions to check student's skills in this domain. The guide is designated for students from General Medicine of 6th year and Dentistry of 4th year. The author considers that this guide will be a useful source of university practical skills.

DESCRIEREA CIP A CAMEREI NAȚIONALE A CĂRȚII
Paraschiv, Angela.
The system of antiepidemic measures disinfection, sterilization, deratization and dezinsection: Methodical guide for medical students / Angela Paraschiv; State Medical and Pharmaceutical Univ. *Nicolae Testemitanu,* Epidemiology Dep. – Ch.: *Medicina,* 2012. – 46 p.
Bibliog.: p. 46 (6 tit.). – 30 ex.
ISBN 978-9975-113-37-3
616.9-084(076.5)
P 33

ISBN 978-9975-113-37-3

CONTENTS

THE SYSTEM OF ANTIEPIDEMIC MEASURES. CLASIFICATION

Introduction

Globalization has led to an increase in the spread of emerging and re-emerging infectious diseases. International efforts are being launched to control their dissemination through global surveillance, a major hindrance to which is the failure of some countries to report outbreaks. Current guidelines and regulations on emerging and re-emerging infectious diseases do not sufficiently take into account the fact that when developing countries report outbreaks they often derive few benefits and suffer disproportionately heavy social and economic consequences. The system of anti-epidemic measures is a set of justified actions from the scientific-practical standpoint aimed to infectious diseases prevention and control.

The system of anti-epidemic measures is aimed in order to prevent, control and eliminate the occurrence and epidemic of infectious diseases and to ensure the health of the people. These issues have an importance role in prevention and sometimes it is underestimated. In intestinal, coetaneous, blood borne and respiratory infections disinfection measures in the focus presents one of the main measure in combating of these kinds of diseases.

In the world, a lot of surgical procedures are performed each year. Each procedure involves contact by a medical device or surgical instrument with a patient's sterile tissue or mucous membranes. A major risk of all such procedures is the introduction of pathogens that can lead to infection. Failure to properly disinfect or sterilize equipment carries not only risk associated with breach of host barriers but also risk for person-to-person transmission (e.g., hepatitis B virus) and transmission of environmental pathogens (e.g., *Pseudomonas aeruginosa*).

Multiple studies in many countries have documented lack of compliance with established guidelines for disinfection and sterilization. Failure to comply with scientifically-based guidelines has led to numerous outbreaks. This guideline presents a pragmatic approach to the judicious selection and proper use of disinfection and sterilization processes; the approach is based on well-designed studies assessing the efficacy

(through laboratory investigations) and effectiveness (through clinical studies) of disinfection and sterilization procedures.

Study Goal

This study is aimed to get information about the system of prophylactic and anti-epidemic measures in infectious diseases at the ambulatory and hospital level.

Lesson plan

1. Evaluation of initial knowledge.
2. Discussion about prophylactic and anti-epidemic measures at the ambulatory level.
3. Discussion about prophylactic and anti-epidemic measures at the hospital level.
4. Discussion on practical assignments.

Providing material

The study is organized at the Epidemiology department. Students will have the opportunity to analyze anti-epidemic measures system in Republic of Moldova.

Students must know

- To organize anti-epidemic measures in ambulatory conditions.
- To determine the quality and efficiency of anti-epidemic measures and detection methods of infectious disease persons.
- Appreciate the quality of primary anti-epidemic measures.

Informative support

The system of anti-epidemic measures has big role in human health. The objectives are:

1. prevention of infectious diseases;
2. reducing the incidence;
3. elimination of incidence;
4. eradication of the infectious disease.

An important role in prevention and control of infectious diseases has a medical staff from ambulatory level. One of the physicians task is precocious detection of the diseased persons, in order to undertake all anti-epidemic measures in time. Diseased person's detection can be acti-

ve and passive. Active detection is performed during the prophylactic examination of person or during the surveillance after the epidemic focus. Passive detection is considered when diseased person with evidence symptoms address to the physicians for the medical assistance.

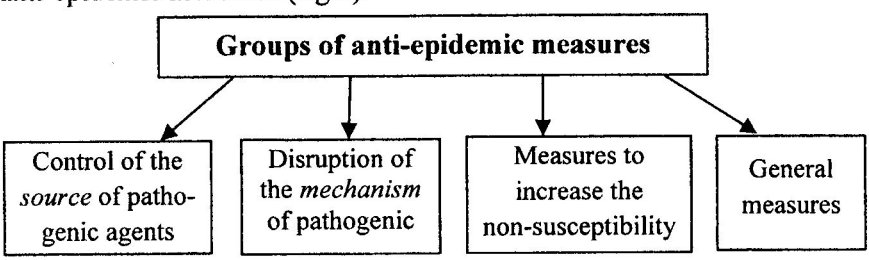
The system of anti-epidemic measures includes 2 issues:

1. prophylactic measures
2. anti-epidemic measures.

Prophylactic measures are aimed, in order to prevent the appearance of infectious diseases. It can be performed daily, especially in crowded institutions like clinics, hospitals, stations, etc.

Anti-epidemic measures are aimed to reduce the incidence of infectious diseases, and liquidate the foci existed already. It is performed when we have contagious people and it is necessary to liquidate the focus, in order to prevent it spreading to others susceptible persons.

The classification of anti-epidemic measures is performed depending on epidemic process components. The epidemic process has 3 main components: source of infection, mechanism of transmission and susceptible population. According to these 3 components will be undertook anti-epidemic measures (fig.1).



Control of the source of pathogenic agents

In anthroponoses:

- *clinical and diagnostical actions:*
  - precocious detection of the patient;
  - properly and timely collection of the samples from patients;
  - etiotropic treatment;
  - emergency information.
- *isolating the patient with an infectious disease:*
  - at home;
  - hospitalization.

- antiepidemic measures in the hotbed:
  - Establishing the borders;
  - Surveillance of the persons that have had contact with the diseased;
  - Using the emergency prophylaxis measures;
  - Isolation and restriction measures in the hotbed;
  - performing disinfection and disinsection measures.
- liquidating the hotbed

In order, for early detection of patients with infectious diseases, practitioners must possess not only the clinical methods of diagnosis, but epidemiological features of various infectious diseases, specific laboratory diagnosis and epidemiological history methods as well. After diagnosis, practitioners have to complete form "'Emergency information about the case of infectious disease, food poisoning or acute professional or unusual reaction to the vaccine". This form is send by post not later than 12 hours after patient detection. If is required an emergency hospitalization, up to sending sheet "Emergency Information", family doctor may communicate by phone about this case to Center of Public Health. In order, for efficient surveillance, family doctor receives the patient epidemiological number, which is noted in his documentation.

In zooanthroponosis has to be performed following measures:

- Similar to those taken in anthroponoses (for zooanthroponosis of domestic animals)
- Radical measures – killing the diseased animals and using the animal products only after the thermal processing.
- Exterminating, burying and cremation of the animals.

Practical assignments

1. Fill the bellow table with the name of the infectious diseases depending on the source of pathogenic agent: anthrax, rabies, tularemia, dysentery, tuberculoses, salmonellosis, cholera, typhoid fever, viral hepatitis A, B, C, D; plague, measles, mumps, Hantavirus pulmonary syndrome, Q fever, lice-borne typhus, pertusis, leptospirosis, malaria, influenza, scarlet fever.

Human person	Domestic animals	Rodents

2. The family doctor diagnosed acute dysentery at patient K., 26 years old, working in the kindergarten. The patient lives in the apartment. The family consists of – husband, the trolleybus driver, child 4 years - attend kindergarten and patient mother – cooker at the hospital.

Elaborate necessary anti-epidemic measures that should be organized by family doctor.

3. Show the type of disinfection with a "+" sign.

Nr. ord	Example of disinfection	Type of disinfection		
		Preventive disinfection	Current focus disinfection	Terminal focus disinfection
1.	Boiling of cutlery (dishes, plates, forks, cup, etc) after being used by a ill person with dysentery in home conditions			
2.	Chlorination of potable water			
3.	Treatment of toilet area with a solution of chlorate lime in the department of infectious diseases of a hospital			
4.	Milk pasteurization.			
5.	Treatment of the objects (pillow, blankets, walls, floor) with a solution of chlorate lime in the ward of the department of infectious diseases of a hospital after discharge of a patient.			
6.	Disinfection of all objects used by the patient after his/her death.			
7.	Treatment of excrements of a ill patient with cholera with disinfectant.			

QUIZ QUESTIONS

1. List the family doctor duty at the anti-epidemic measures chapter.
2. What kind of anti-epidemic measures has to undertake family doctor in case of patient isolation at home.
3. List the anti-epidemic measures oriented to the source of infection and mechanism of transmission.

4. Organization and content of anti-epidemic measures in anthroponosis.
5. Organization and content of anti-epidemic measures in zooanthroponosis.
6. Epidemiological importance of animals as source of infection.
7. Organization and content of anti-epidemic measures in sapronosis.

DISINFECTION. DISINFECTANTS AND ITS USING. OVEN DISINFECTION

Introduction

Importance of interruption of transmission mechanism in some infections, by combating causative agents founded in the environmental factors, transmitted by different methods, is impossible to overestimate. Peculiarities of epidemic process and anti-epidemic practice have shown that disinfection in general meaning of the word is necessary and effective only in complex with other prophylactic and anti-epidemic measures.

Study goal – to develop theoretical knowledge of disinfection, methods of disinfectants using and technical means.

Lesson plan

1. Initial knowledge assessment.
2. Discussion about disinfection methods and organization of disinfection in infectious diseases foci.
3. Practical assignments.
4. Discussion on disinfection work performed in foci.

Materials support

The study is organized at the Epidemiology department. Samples of disinfectants, tools for disinfection. Figures.

Student must know

1. Definition of disinfection.
2. Role of disinfection in the system of anti-epidemic measures.
3. Classification of disinfection.
4. Methods of disinfection (mechanical, physical, chemical, biological).
5. Main groups of chemical substances used as disinfectants (phenol, chlorine and its compounds, quaternary ammonium salts, formaldehyde, acids, oxidants, alcohols).
6. Disinfection in different group of infections.
7. Disinfection in chambers

Informative support

Disinfection is essential for ensuring that medical and surgical instruments do not transmit infectious pathogens to patients. Because sterilization of all patient-care items is not necessary, health-care policies must identify, primarily on the basis of the items' intended use, whether cleaning, disinfection, or sterilization is indicated.

Disinfection – is a set of measures of extermination of infectious diseases pathogenic agents on different elements, objects of the environment.

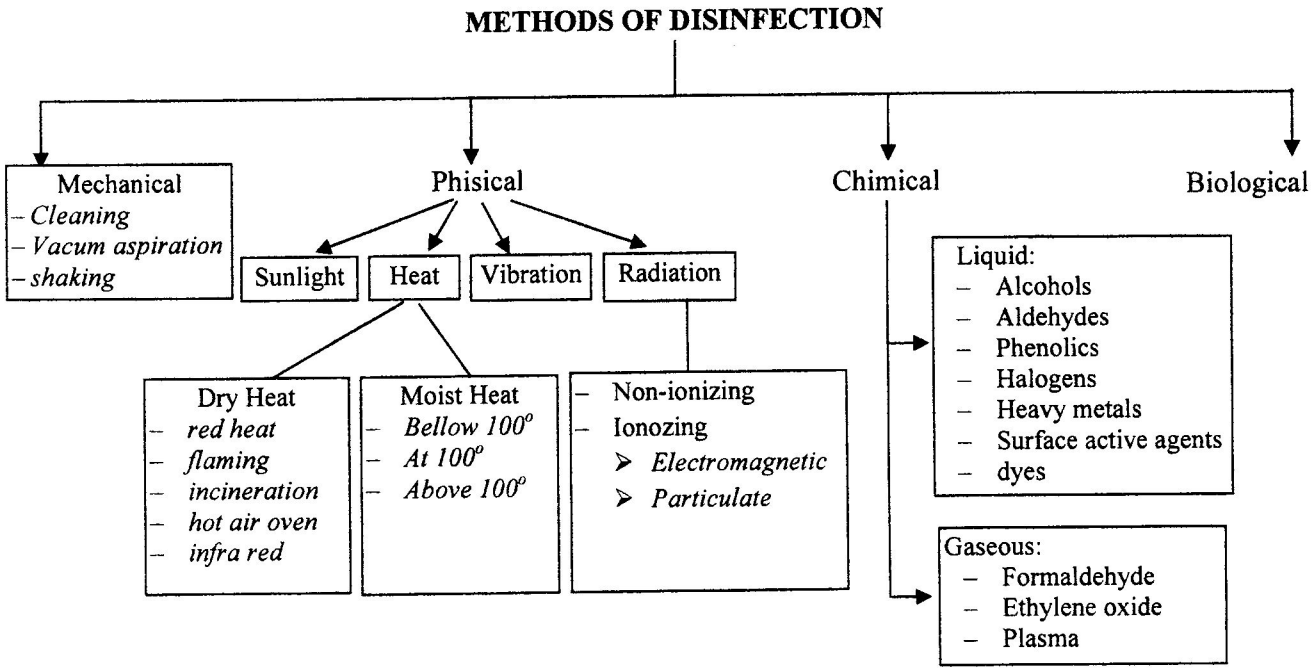
Disinfection importance, the selected means and methods of realization at the different infections are different, therefore report measures of disinfection and other preventive measures and epidemic is different in various infections.

Many disinfectants are used alone or in combinations (e.g., hydrogen peroxide and peracetic acid) in the health-care setting. These include alcohols, chlorine and chlorine compounds, formaldehyde, glutaraldehyde, *ortho*-phthalaldehyde, hydrogen peroxide, iodophors, peracetic acid, phenolics, and quaternary ammonium compounds. Commercial formulations based on these chemicals are considered unique products and must be registered with EPA or cleared by FDA. In most instances, a given product is designed for a specific purpose and is to be used in a certain manner. Therefore, users should read labels carefully to ensure the correct product is selected for the intended use and applied efficiently.

Cleaning is the removal of visible soil (e.g., organic and inorganic material) from objects and surfaces and normally is accomplished manually or mechanically using water with detergents or enzymatic products. Thorough cleaning is essential before high-level disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes. *Decontamination* removes pathogenic microorganisms from objects so they are safe to handle, use, or discard.

Physical methods of sterilization:

Sunlight: The microbicidal activity of sunlight is mainly due to the presence of ultra violet rays in it. It is responsible for spontaneous sterilization in natural conditions. In tropical countries, the sunlight is more effective in killing germs due to combination of ultraviolet rays and


METHODS OF DISINFECTION
Mechanical
– Cleaning
– Vacum aspiration
– shaking
Phisical
Sunlight
Heat
Vibration
Radiation
Dry Heat
– red heat
– flaming
– incineration
– hot air oven
– infra red
Moist Heat
– Bellow 100°
– At 100°
– Above 100°
– Non-ionizing
– Ionozing
➢ Electromagnetic
➢ Particulate
Chimical
Liquid:
– Alcohols
– Aldehydes
– Phenolics
– Halogens
– Heavy metals
– Surface active agents
– dyes
Gaseous:
– Formaldehyde
– Ethylene oxide
– Plasma
Biological

heat. By killing bacteria suspended in water, sunlight provides natural method of disinfection of water bodies such as tanks and lakes. Sunlight is not sporicidal, hence it does not sterilize.

Heat: Heat is considered to be most reliable method of sterilization of articles that can withstand heat. Heat acts by oxidative effects as well as denaturation and coagulation of proteins. Those items that cannot withstand high temperatures can still be sterilized at lower temperature by prolonging the duration of exposure.

Factors affecting sterilization by heat are:

- ✓ Nature of heat: Moist heat is more effective than dry heat
- ✓ Temperature and time: temperature and time are inversely proportional. As temperature increases the time taken decreases.
- ✓ Number of microorganisms: More the number of microorganisms, higher the temperature or longer the duration required.
- ✓ Nature of microorganism: Depends on species and strain of microorganism, sensitivity to heat may vary. Spores are highly resistant to heat.
- ✓ Type of material: Articles that are heavily contaminated require higher temperature or prolonged exposure. Certain heat sensitive articles must be sterilized at lower temperature.
- ✓ Presence of organic material: Organic materials such as protein, sugars, oils and fats increase the time required.

Action of heat:

Dry heat acts by protein denaturation, oxidative damage and toxic effects of elevated levels of electrolytes. The moist heat acts by coagulation and denaturation of proteins. Moist heat is superior to dry heat in action. Temperature required to kill microbe by dry heat is more than the moist heat. Thermal death time is the minimum time required to kill a suspension of organisms at a predetermined temperature in a specified environment.

Dry heat:

Red heat: Articles such as bacteriological loops, straight wires, tips of forceps and searing spatulas are sterilized by holding them in Bunsen flame till they become red hot. This is a simple method for effective sterilization of such articles, but is limited to those articles that can be heated to redness in flame.

Flaming: This is a method of passing the article over a Bunsen flame, but not heating it to redness. Articles such as scalpels, mouth of test tubes, flasks, glass slides and cover slips are passed through the flame a few times. Even though most vegetative cells are killed, there is no guarantee that spores too would die on such short exposure. This method too is limited to those articles that can be exposed to flame. Cracking of the glassware may occur.

Incineration: This is a method of destroying contaminated material by burning them in incinerator. Articles such as soiled dressings; animal carcasses, pathological material and bedding etc should be subjected to incineration. This technique results in the loss of the article, hence is suitable only for those articles that have to be disposed. Burning of polystyrene materials emits dense smoke, and hence they should not be incinerated.

Infra red rays: Infrared rays bring about sterilization by generation of heat. Articles to be sterilized are placed in a moving conveyer belt and passed through a tunnel that is heated by infrared radiators to a temperature of 180°C.

The articles are exposed to that temperature for a period of 7.5 minutes. Articles sterilized included metallic instruments and glassware. It is mainly used in central sterile supply department. It requires special equipments, hence is not applicable in diagnostic laboratory.

Moist heat:

Moist heat acts by coagulation and denaturation of proteins.

At temperature below 100°C:

f Pasteurization: This process was originally employed by Louis Pasteur. Currently this procedure is employed in food and dairy industry. There are two methods of pasteurization, the holder method (heated at 63°C for 30 minutes) and flash method (heated at 72°C for 15 seconds) followed by quickly cooling to 13°C.

Other pasteurization methods include Ultra-High Temperature (UHT), 140°C for 15 sec and 149°C for 0.5 sec. This method is suitable to destroy most milk borne pathogens like Salmonella, Mycobacteria, Streptococci, Staphylococci and Brucella, however Coxiella may survive pasteurization. Efficacy is tested by phosphatase test and methylene blue test.

At temperature 100°C:

Boiling: Boiling water (100°C) kills most vegetative bacteria and viruses immediately. Certain bacterial toxins such as Staphylococcal enterotoxin are also heat resistant. Some bacterial spores are resistant to boiling and survive; hence this is not a substitute for sterilization. The killing activity can be enhanced by addition of 2% sodium bicarbonate. When absolute sterility is not required, certain metal articles and glasswares can be disinfected by placing them in boiling water for 10-20 minutes. The lid of the boiler must not be opened during the period.

Steam at 100°C: Instead of keeping the articles in boiling water, they are subjected to free steam at 100°C. Traditionally Arnold's and Koch's steamers were used. An autoclave (with discharge tap open) can also serve the same purpose. A steamer is a metal cabinet with perforated trays to hold the articles and a conical lid. The bottom of steamer is filled with water and heated. The steam that is generated sterilizes the articles when exposed for a period of 90 minutes. Media such as TCBS, DCA and selenite broth are sterilized by steaming. Sugar and gelatin in medium may get decomposed on autoclaving, hence they are exposed to free steaming for 20 minutes for three successive days. This process is known as tyndallisation (after John Tyndall) or fractional sterilization or intermittent sterilization. The vegetative bacteria are killed in the first exposure and the spores that germinate by next day are killed in subsequent days. The success of process depends on the germination of spores.

RADIATION:

Two types of radiation are used, ionizing and non-ionizing. Non-ionizing rays are low energy rays with poor penetrative power while ionizing rays are high-energy rays with good penetrative power. Since radiation does not generate heat, it is termed "cold sterilization". In some parts of Europe, fruits and vegetables are irradiated to increase their shelf life up to 500 percent.

CHEMICAL METHODS OF DISINFECTION

Disinfectants are those chemicals that destroy pathogenic bacteria from inanimate surfaces. Some chemical have very narrow spectrum of activity and some have very wide. Those chemicals that can sterilize are called chemisterilants. Those chemicals that can be safely applied over

skin and mucus membranes are called antiseptics. An ideal antiseptic or disinfectant should have following properties:

1. Should have wide spectrum of activity
2. Should be able to destroy microbes within practical period of time
3. Should be active in the presence of organic matter
4. Should make effective contact and be wettable
5. Should be active in any pH
6. Should be stable
7. Should have long shelf life
8. Should be speedy
9. Should have high penetrating power
10. Should be non-toxic, non-allergenic, non-irritative or non-corrosive
11. Should not have bad odour
12. Should not leave non-volatile residue or stain
13. Efficacy should not be lost on reasonable dilution
14. Should not be expensive and must be available easily

Such an ideal disinfectant is not yet available. The level of disinfection achieved depends on contact time, temperature, type and concentration of the active ingredient, the presence of organic matter, the type and quantum of microbial load. The chemical disinfectants at working concentrations rapidly lose their strength on standing.

Classification of disinfectants:

1. Based on consistency
   a. Liquid (E.g., Alcohols, Phenols)
   b. Gaseous (Formaldehyde vapor, Ethylene oxide)
2. Based on spectrum of activity
   a. High level
   c. Intermediate level
   d. Low level
3. Based on mechanism of action
   a. Action on membrane (E.g., Alcohol, detergent)
   b. Denaturation of cellular proteins (E.g., Alcohol, Phenol)
   c. Oxidation of essential sulphydryl groups of enzymes (E.g., H2O2, Halogens)

d. Alkylation of amino-, carboxyl- and hydroxyl group (E.g., Ethylene Oxide, Formaldehyde)
e. Damage to nucleic acids (Ethylene Oxide, Formaldehyde)

Spectrum of activity

	Vegetative cells	Mycobacteria	Spores	Fungi	Viruses	Examples
High level	+	+	+	+	+	Ethylene Oxide, Gluteraldehyde, Formaldehyde
Intermediate level	+	+	–	+	+	Phenolics, halogens
Low level	+	–	–	+	+/–	Alcohols, quaternary ammonium compounds

ALCOHOLS:

Mode of action: Alcohols dehydrate cells, disrupt membranes and cause coagulation of protein.

Examples: Ethyl alcohol, isopropyl alcohol and methyl alcohol

Application: A 70% aqueous solution is more effective at killing microbes than absolute alcohols. 70% ethyl alcohol (spirit) is used as antiseptic on skin. Isopropyl alcohol is preferred to ethanol. It can also be used to disinfect surfaces. It is used to disinfect clinical thermometers. Methyl alcohol kills fungal spores, hence is useful in disinfecting inoculation hoods. Disadvantages: Skin irritant, volatile (evaporates rapidly), inflammable.

ALDEHYDES:

Mode of action: Acts through alkylation of amino-, carboxyl- or hydroxyl group, and probably damages nucleic acids. It kills all microorganisms, including spores.

Examples: Formaldehyde, Gluteraldehyde

Application: 40% Formaldehyde (formalin) is used for surface disinfection and fumigation of rooms, chambers, operation theatres, biological safety cabinets, wards, sick rooms etc. Fumigation is achieved by boiling formalin, heating paraformaldehyde or treating formalin with

potassium permanganate. It also sterilizes bedding, furniture and books. 10% formalin with 0.5% tetraborate sterilizes clean metal instruments. 2% gluteraldehyde is used to sterilize thermometers, cystoscopes, bronchoscopes, centrifuges, anasethetic equipments etc. An exposure of at least 3 hours at alkaline pH is required for action by gluteraldehyde. 2% formaldehyde at 40°C for 20 minutes is used to disinfect wool and 0.25% at 60°C for six hours to disinfect animal hair and bristles.

Disadvantages: Vapors are irritating (must be neutralized by ammonia), has poor penetration, leaves non-volatile residue, activity is reduced in the presence of protein. Gluteraldehyde requires alkaline pH and only those articles that are wettable can be sterilized.

PHENOL

Mode of action: Act by disruption of membranes, precipitation of proteins and inactivation of enzymes.

Examples: 5% phenol, 1–5% Cresol, 5% Lysol (a saponified cresol), hexachlorophene, chlorhexidine, chloroxylenol (Dettol)

Applications: Joseph Lister used it to prevent infection of surgical wounds. Phenols are coal-tar derivatives. They act as disinfectants at high concentration and as antiseptics at low concentrations. They are bactericidal, fungicidal, mycobactericidal but are inactive against spores and most viruses. They are not readily inactivated by organic matter. The corrosive phenolics are used for disinfection of ward floors, in discarding jars in laboratories and disinfection of bedpans. Chlorhexidine can be used in an isopropanol solution for skin disinfection, or as an aqueous solution for wound irrigation. It is often used as an antiseptic hand wash. 20% Chlorhexidine gluconate solution is used for pre-operative hand and skin preparation and for general skin disinfection. Chlorhexidine gluconate is also mixed with quaternary ammonium compounds such as cetrimide to get stronger and broader antimicrobial effects (eg. Savlon). Chloroxylenols are less irritant and can be used for topical purposes and are more effective against gram positive bacteria than gram negative bacteria. Hexachlorophene is chlorinated diphenyl and is much less irritant. It has marked effect over gram positive bacteria but poor effect over gram negative bacteria, mycobacteria, fungi and viruses. Triclosan is an organic phenyl ether with good activity against gram positive bacteria and effective to some extent against many gram

negative bacteria including Pseudomonas. It also has fair activity on fungi and viruses.

Disadvantages: It is toxic, corrosive and skin irritant. Chlorhexidine is inactivated by anionic soaps. Chloroxylenol is inactivated by hard water.

HALOGENS

Mode of action: They are oxidizing agents and cause damage by oxidation of essential sulfydryl groups of enzymes. Chlorine reacts with water to form hypochlorous acid, which is microbicidal.

Examples: Chlorine compounds (chlorine, bleach, hypochlorite) and iodine compounds (tincture iodine, iodophores)

Applications: Tincture of iodine (2% iodine in 70% alcohol) is an antiseptic. Iodine can be combined with neutral carrier polymers such as polyvinylpyrrolidone to prepare iodophores such as povidone-iodine. Iodophores permit slow release and reduce the irritation of the antiseptic. For hand washing iodophores are diluted in 50% alcohol. 10% Povidone Iodine is used undiluted in pre and postoperative skin disinfection. Chlorine gas is used to bleach water. Household bleach can be used to disinfect floors. Household bleach used in a stock dilution of 1:10. In higher concentrations chlorine is used to disinfect swimming pools. 0.5% sodium hypochlorite is used in serology and virology. Used at a dilution of 1:10 in decontamination of spillage of infectious material. Mercuric chloride is used as a disinfectant.

Disadvantages: They are rapidly inactivated in the presence of organic matter. Iodine is corrosive and staining. Bleach solution is corrosive and will corrode stainless steel surfaces. Metabolise cetrimide, using them as a carbon, nitrogen and energy source.

ACIDS – more frequent are active against vegetative forms of microorganisms. Organic acids have lower disinfecting properties than non-organic ones.

CHLORINE AND CHLORINE COMPOUNDS

Hypochlorites, the most widely used of the chlorine disinfectants, are available as liquid (e.g., sodium hypochlorite) or solid (e.g., calcium hypochlorite). They have a broad spectrum of antimicrobial activity, do not leave toxic residues, are unaffected by water hardness, are inexpensive and fast acting remove dried or fixed organisms and biofilms

from surfaces , and have a low incidence of serious toxicity. Sodium hypochlorite at the concentration used in household bleach (5.25-6.15%) can produce ocular irritation or oropharyngeal, esophageal, and gastric burns. Other disadvantages of hypochlorites include corrosiveness to metals in high concentrations (>500 ppm), inactivation by organic matter, discoloring or "bleaching" of fabrics, release of toxic chlorine gas when mixed with ammonia or acid (e.g., household cleaning agents) and relative stability. The microbicidal activity of chlorine is attributed largely to undissociated hypochlorous acid (HOCl). The dissociation of HOCl to the less microbicidal form (hypochlorite ion OCl) depends on pH. The disinfecting efficacy of chlorine decreases with an increase in pH that parallels the conversion of undissociated HOCl to OCl. A potential hazard is production of the carcinogen bis(chloromethyl) ether when hypochlorite solutions contact formaldehyde and the production of the animal carcinogen trihalomethane when hot water is hyperchlorinated. After reviewing environmental fate and ecologic data, EPA has determined the currently registered uses of hypochlorites will not result in unreasonable adverse effects to the environment.

In our republic for disinfection are widely used lime chloride and chloramine.

LIME CHLORIDE – is a white powder with chlorine odor. Is unstable substances, and decreases slightly if it is kept in unfavorable conditions (light action and high temperature). It is stored in barrels or paper bags, tightly closed. Not stored in the same space with metal ferrous objects that oxidizes. In terms of good keeping chloride of lime monthly loses 1% active chlorine. Therefore for large stocks is recommended to calibrate periodically the active chlorine concentration. When it is below 25%, are made corrections in calculating of the work concentration according to the formula:

$$x = \frac{25 * a}{b}$$

where: *25* – % of active chlorine in standard substances;

a – necessary quantity of lime chloride, which contains 25% of active chlorine;

b – % of active chlorine in used lime chloride.

In case if active chlorine is below 15% it cannot be used for disinfection.

Lime chloride has wide action spectrum. It is the cheapest disinfectant substances but has some disadvantages:

- Unstable substance, special in solutions;
- Discoloration of clothes;
- Decrease the resistance of tissues;
- corrode ferrous metals;
- is irritating to the respiratory mucosa
- disinfectant power decreases in the presence of organic substances

Lime chloride can be used as suspension, solution and powder. Suspension of lime chloride in water 10% or 20% is used for disinfection of pathological products (sputum, pus, blood, feces, urine, vomiting), toilets, stables, garbage, etc. To obtain a suspension of fine particles, into the the amount of calculated lime chloride, add a small amount of warm water, mix until a paste is obtained, then add water until 10 litters. This will get 10% or 20% of the clarified solution of lime chloride. Due to rapid release of active chlorine, working solutions of lime chloride cannot be maintained but will be used only on the day of preparation.

The concentration of 0,5–1% solution can be used in disinfection of dishes, which is exposed to the disinfectants action for 1 hour immersion.

Solution of 5–10% can be used for disinfection by wiping the tiles, the toilets floor, removing from handles water tank chain. Ferrous metal objects has to be protected with grease.

1–2% solution of lime chloride can be used for disinfection by spraying the room where patient stayed and disinfection of vehicles.

HYDROGEN PEROXIDE

Hydrogen peroxide is active against a wide range of microorganisms, including bacteria, yeasts, fungi, viruses, and spores. A 0.5% accelerated hydrogen peroxide demonstrated bactericidal and virucidal activity in 1 minute and mycobactericidal and fungicidal activity in 5 minutes. It has been used in concentrations from 3% to 6% for disinfecting soft contact lenses (e.g., 3% for 2–3 hrs), tonometer biprisms, ventilators, and endoscopes.

DISINFECTION IN CHAMBERS

Chambers or ovens are special device designed for disinfection of clothes, shoes, etc. with heat (hot air, hot vapors) and others chemical means (formalin, sulfuric anhydride, methyl bromated, etc). Chamber disinfection is one of the main parts of antiepidemic activity.

Types of chambers:

- with hot vapors at t° of 100–120 °C and the excessive pressure of 0,2–1 atm.
- with vapors and formalin at the t° of 40–59 °C.
- with hot air at the temperature of 80–90 °C .

In chambers with vapors the disinfection action has saturated vapors, which penetrate very quickly and deep into the things and heat it uniformly. Disinfection in these chambers is performed at the normal pressure till 0,2-1atm and temperature from 100 till 120°C .

Steps of disinfection in chambers with hot vapors:

1. Technical examination of the chamber and heating it till 80°C.
2. Load the oven with things for disinfection. Clothes are arranged in oven in 10–12 sets per $1m^3$ (1 set =6 kg).
3. The oven with things is heated and is evacuated air from it through pipe. The relevant time that has to be recorded is from the moment when the temperature will achieve 100°C.
4. After the exposure time is finished, the entrance of vapors is stopped and has to be opened exhaust valves of vapors and ventilation pipes, decreasing the pressure in oven till zero.
5. When the pressure is back to normal, the oven is ventilated and all things are drying. To achieve it is necessary to open the ventilation door for 10–14 min at the temperature of 40–50°C.
6. After drying the things are removing from the oven.

In chambers (oven) with formalin and vapors the active agents are vapors, formaldehyde, and hot air heated till 40–59°C.

In chambers with hot air disinfection is performed at the 80–98°C temperature, but disinsection 49–98°C. The relative humidity has to be not less than 80–90%

The control of the disinfection quality

The control of disinfection quality is performed by specialists from disinfection department, prophylactic department and focus disinfection department, and laboratory of medical institutions.

There are 3 types of quality control:

1. Visual control;
2. Chemical control;
3. Bacteriological control.

Visual control determine the disinfection state of the object, if the disinfection is performed in correct place, correct moment and full volume, the quality of room surface treatment, the quantity of disinfected things in oven.

Chemical control determines the content of the active compounds into preparations and working solutions, corresponding of work solution concentration with legislation and its keeping.

Bacteriological control consists in determination of bacteriological microorganisms on surfaces or disinfected things. Also, can be isolation of E.coli in the focus of intestinal infectious diseases, Staphylococcus in focus with respiratory infections, mycobacterium tuberculosis or staphylococcus in tuberculosis focus, etc. Bacteriological control is performed unexpected by specialist from disinfection department. Samples are collected not later than 30–45 min after finishing the disinfection and the control is performed not later than 2 hours after its collection.

Control of oven disinfection

1. *Technical control.* Are examined ovens and technical registers of ovens where are recorded: state of the control devices and measure devices (thermometer, manometer), functioning of ventilation valves, taps.

2. *Thermal control.* Is determined the temperature inside of the oven with: maximum thermometer, chemical indicators with melting temperature determined (sulfur – 120°C, resorcin – 110 °C, naphthalene – 80 °C). Thermometers and indicators are arranged by 5 in different part at 3 levels.

3. *Bacteriological control.* Is performed with test-objects. Pieces of cambric with 0,5x1 cm dimension impregnated with: a) staphylococcus

aureus, b) mycobacterium B-5, c) anthracoids depending on disinfection regime are placed by 5 in different places at 3 levels. The result is given after 24 hours from the laboratory.

4. *Biological control.* Is used insects-test in tubes or bags with lice or linden that are placed by 5 at 3 levels of oven. When disinfection (disinsection) is finished the result, in case of lice using, will be immediately. In case of the linden, the result will be after 5–7 days of incubation it in thermostat.

QUIZ QUESTIONS

1. What is prophylactic disinfection?
2. Who is responsible for organization of current disinfection?
3. What and how many times have to be disinfected during the day in current disinfection?
4. How can be appreciated the quality of the current disinfection?
5. Who is responsible for organization of terminal disinfection in the focus?
6. How can be appreciated the quality of the terminal disinfection?
7. What methods and what kind of disinfectants are used in focus with intestinal diseases?
8. How is performed the disinfection in focus with hepatitis caused by virus „A"?
9. What has to be disinfected and what tools will be used in diphtheria focus?
10. What peculiarities are characteristics for disinfection in focus with anthrax?
11. What peculiarities are characteristics for disinfection in focus with endemic typhus?
12. What kind of ovens is used for disinfection in dysentery focus?
13. What kind of ovens is used for disinfection in anthrax focus?
14. How can be appreciated the quality of terminal disinfection?

STERILIZATION

Sterilization – a set of measures for the inactivation of all microorganisms (pathogenic and saprophytes) that can contaminate different objects and substrates etc. While the use of inadequately sterilized critical items represents a high risk of transmitting pathogens, documented transmission of pathogens associated with an inadequately sterilized critical item is exceedingly rare.

Phases of sterilization of medical instruments:

1. Cleaning the instruments
2. Sterilization

Antesterilization includes: sorting, soaking, washing, rinsing, and drying.

Critical Items

Critical items confer a high risk for infection if they are contaminated with any microorganism. Thus, objects that enter sterile tissue or the vascular system must be sterile because any microbial contamination could transmit disease. This category includes surgical instruments, cardiac and urinary catheters, implants, and ultrasound probes used in sterile body cavities. Most of the items in this category should be purchased as sterile or be sterilized with steam if possible. Heat-sensitive objects can be treated with EtO, hydrogen peroxide gas plasma; or if other methods are unsuitable, by liquid chemical sterilants. Germicides categorized as chemical sterilants include ≥2.4% glutaraldehyde-based formulations, 0.95% glutaraldehyde with 1.64% phenol/phenate, 7.5% stabilized hydrogen peroxide, 7.35% hydrogen peroxide with 0.23% peracetic acid, 0.2% peracetic acid, and 0.08% peracetic acid with 1.0% hydrogen peroxide. Liquid chemical sterilants reliably produce sterility only if cleaning precedes treatment and if proper guidelines are followed regarding concentration, contact time, temperature, and pH.

Semicritical Items

Semicritical items contact mucous membranes or nonintact skin. This category includes respiratory therapy and anesthesia equipment, some endoscopes, laryngoscope blades, esophageal manometry probes, cystoscopes, anorectal manometry catheters, and diaphragm fitting rings. These medical devices should be free from all microorganisms; however, small numbers of bacterial spores are permissible. Intact mucous

membranes, such as those of the lungs and the gastrointestinal tract, generally are resistant to infection by common bacterial spores but susceptible to other organisms, such as bacteria, mycobacteria, and viruses. Semicritical items minimally require high-level disinfection using chemical disinfectants. Glutaraldehyde, hydrogen peroxide, *ortho*-phthalaldehyde, and peracetic acid with hydrogen peroxide are cleared by the Food and Drug Administration (FDA) and are dependable high-level disinfectants provided the factors influencing germicidal procedures are met. When a disinfectant is selected for use with certain patient-care items, the chemical compatibility after extended use with the items to be disinfected also must be considered.

High-level disinfection traditionally is defined as complete elimination of all microorganisms in or on an instrument, except for small numbers of bacterial spores. The FDA definition of high-level disinfection is a sterilant used for a shorter contact time to achieve a 6-log10 kill of an appropriate *Mycobacterium* species. Cleaning followed by high-level disinfection should eliminate enough pathogens to prevent transmission of infection.

Laparoscopes and arthroscopes entering sterile tissue ideally should be sterilized between patients. However, in the United States, this equipment sometimes undergoes only high-level disinfection between patients. 28–30 As with flexible endoscopes, these devices can be difficult to clean and high-level disinfect or sterilize because of intricate device design (e.g., long narrow lumens, hinges). Meticulous cleaning must precede any high-level disinfection or sterilization process. Although sterilization is preferred, no reports have been published of outbreaks resulting from high-level disinfection of these scopes when they are properly cleaned and high-level disinfected. Newer models of these instruments can withstand steam sterilization that for critical items would be preferable to high-level disinfection.

Rinsing endoscopes and flushing channels with sterile water, filtered water, or tap water will prevent adverse effects associated with disinfectant retained in the endoscope (e.g., disinfectant-induced colitis). Items can be rinsed and flushed using sterile water after high-level disinfection to prevent contamination with organisms in tap water, such as nontuberculous mycobacteria, *Legionella*, or gram-negative bacilli such as *Pseudomonas*. Alternatively, a tapwater or filtered water (0.2μ filter)

rinse should be followed by an alcohol rinse and forced air drying. Forced-air drying markedly reduces bacterial contamination of stored endoscopes, most likely by removing the wet environment favorable for bacterial growth. After rinsing, items should be dried and stored (e.g., packaged) in a manner that protects them from recontamination.

Some items that may come in contact with nonintact skin for a brief period of time (i.e., hydrotherapy tanks, bed side rails) are usually considered noncritical surfaces and are disinfected with intermediate-level disinfectants (i.e., phenolic, iodophor, alcohol, chlorine). Since hydrotherapy tanks have been associated with spread of infection, some facilities have chosen to disinfect them with recommended levels of chlorine

In the past, high-level disinfection was recommended for mouthpieces and spirometry tubing (e.g., glutaraldehyde) but cleaning the interior surfaces of the spirometers was considered unnecessary. This was based on a study that showed that mouthpieces and spirometry tubing become contaminated with microorganisms but there was no bacterial contamination of the surfaces inside the spirometers. Filters have been used to prevent contamination of this equipment distal to the filter; such filters and the proximal mouthpiece are changed between patients.

Noncritical Items

Noncritical items are those that come in contact with intact skin but not mucous membranes. Intact skin acts as an effective barrier to most microorganisms; therefore, the sterility of items coming in contact with intact skin is "not critical." In this guideline, noncritical items are divided into noncritical patient care items and noncritical environmental surfaces 43, 44. Examples of noncritical patient-care items are bedpans, blood pressure cuffs, crutches and computers 45. In contrast to critical and some semicritical items, most noncritical reusable items may be decontaminated where they are used and do not need to be transported to a central processing area. Virtually no risk has been documented for transmission of infectious agents to patients through noncritical items when they are used as noncritical items and do not contact non-intact skin and/or mucous membranes. Table 1 lists several low-level disinfectants that may be used for noncritical items. Most Environmental Protection Agency (EPA)-registered disinfectants have a 10-minute label claim. However, multiple investigators have demonstrated the effectiveness of these disinfectants against vegetative bacteria (e.g., *Listeria, Escherichia*

coli, *Salmonella*, vancomycin-resistant Enterococci, methicillin-resistant *Staphylococcus aureus*), yeasts (e.g., *Candida*), mycobacteria (e.g., *Mycobacterium tuberculosis*), and viruses (e.g. poliovirus) at exposure times of 30–60 seconds. Federal law requires all applicable label instructions on EPA-registered products to be followed (e.g., use-dilution, shelf life, storage, material compatibility, safe use, and disposal). If the user selects exposure conditions (e.g., exposure time) that differ from those on the EPA-registered products label, the user assumes liability for any injuries resulting from off-label use and is potentially subject to enforcement action under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Noncritcal environmental surfaces include bed rails, some food utensils, bedside tables, patient furniture and floors. Noncritical environmental surfaces frequently touched by hand (e.g., bedside tables, bed rails) potentially could contribute to secondary transmission by contaminating hands of health-care workers or by contacting medical equipment that subsequently contacts patients. Mops and reusable cleaning cloths are regularly used to achieve low-level disinfection on environmental surfaces. However, they often are not adequately cleaned and disinfected, and if the water-disinfectant mixture is not changed regularly (e.g., after every three to four rooms, at no longer than 60-minute intervals), the mopping procedure actually can spread heavy microbial contamination throughout the health-care facility. In one study, standard laundering provided acceptable decontamination of heavily contaminated mopheads but chemical disinfection with a phenolic was less effective. Frequent laundering of mops (e.g., daily), therefore, is recommended. Single-use disposable towels impregnated with a disinfectant also can be used for low-level disinfection when spot-cleaning of noncritical surfaces is needed.

Alcohol

Overview. In the healthcare setting, "alcohol" refers to two water-soluble chemical compounds – ethyl alcohol and isopropyl alcohol- that have generally underrated germicidal characteristics (William 2008). FDA has not cleared any liquid chemical sterilant or high-level disinfectant with alcohol as the main active ingredient. These alcohols are rapidly bactericidal rather than bacteriostatic against vegetative forms of bacteria; they also are tuberculocidal, fungicidal, and virucidal but do

not destroy bacterial spores. Their cidal activity drops sharply when diluted below 50% concentration, and the optimum bactericidal concentration is 60%–90% solutions in water (volume/volume).

Mode of Action. The most feasible explanation for the antimicrobial action of alcohol is denaturation of proteins. This mechanism is supported by the observation that absolute ethyl alcohol, a dehydrating agent, is less bactericidal than mixtures of alcohol and water because proteins are denatured more quickly in the presence of water. Protein denaturation also is consistent with observations that alcohol destroys the dehydrogenases of *Escherichia coli*, and that ethyl alcohol increases the lag phase of *Enterobacter aerogenes* and that the lag phase effect could be reversed by adding certain amino acids. The bacteriostatic action was believed caused by inhibition of the production of metabolites essential for rapid cell division.

Microbicidal Activity. Methyl alcohol (methanol) has the weakest bactericidal action of the alcohols and thus seldom is used in healthcare. The bactericidal activity of various concentrations of ethyl alcohol (ethanol) was examined against a variety of microorganisms in exposure periods ranging from 10 seconds to 1 hour. *Pseudomonas aeruginosa* was killed in 10 seconds by all concentrations of ethanol from 30% to 100% (v/v), and *Serratia marcescens, E, coli* and *Salmonella typhosa* were killed in 10 seconds by all concentrations of ethanol from 40% to 100%. The gram-positive organisms *Staphylococcus aureus* and *Streptococcus pyogenes* were slightly more resistant, being killed in 10 seconds by ethyl alcohol concentrations of 60%–95%. Isopropyl alcohol (isopropanol) was slightly more bactericidal than ethyl alcohol for *E. coli* and *S. aureus.*

Ethyl alcohol, at concentrations of 60%–80%, is a potent virucidal agent inactivating all of the lipophilic viruses (e.g., herpes, vaccinia, and influenza virus) and many hydrophilic viruses (e.g., adenovirus, enterovirus, rhinovirus, and rotaviruses but not hepatitis A virus (HAV) or poliovirus. Isopropyl alcohol is not active against the nonlipid enteroviruses but is fully active against the lipid viruses [72]. Studies also have demonstrated the ability of ethyl and isopropyl alcohol to inactivate the hepatitis B virus(HBV) and the herpes virus, and ethyl alcohol to inactivate human immunodeficiency virus (HIV), rotavirus, echovirus, and astrovirus .

In tests of the effect of ethyl alcohol against *M. tuberculosis*, 95% ethanol killed the tubercle bacilli in sputum or water suspension within 15 seconds. In 1964, Spaulding stated that alcohols were the germicide of choice for tuberculocidal activity, and they should be the standard by which all other tuberculocides are compared. For example, he compared the tuberculocidal activity of iodophor (450 ppm), a substituted phenol (3%), and isopropanol (70%/volume) using the mucin-loop test (10^6 *M. tuberculosis* per loop) and determined the contact times needed for complete destruction were 120–180 minutes, 45–60 minutes, and 5 minutes, respectively. The mucin-loop test is a severe test developed to produce long survival times. Thus, these figures should not be extrapolated to the exposure times needed when these germicides are used on medical or surgical material.

Ethyl alcohol (70%) was the most effective concentration for killing the tissue phase of *Cryptococcus neoformans*, *Blastomyces dermatitidis*, *Coccidioides immitis*, and *Histoplasma capsulatum* and the culture phases of the latter three organisms aerosolized onto various surfaces. The culture phase was more resistant to the action of ethyl alcohol and required about 20 minutes to disinfect the contaminated surface, compared with <1 minute for the tissue phase.

Factors affecting the efficacy of disinfection and sterilization

The activity of germicides against microorganisms depends on a number of factors, some of which are intrinsic qualities of the organism, others of which are the chemical and external physical environment. Awareness of these factors should lead to better use of disinfection and sterilization processes and will be briefly reviewed. More extensive consideration of these and other factors is available elsewhere. It can be:

1. **Number and Location of Microorganisms** – All other conditions remaining constant, the larger the number of microbes, the more time a germicide needs to destroy all of them.

2. **Innate Resistance of Microorganisms** – Microorganisms vary greatly in their resistance to chemical germicides and sterilization processes

3. **Concentration and Potency of Disinfectants** – With other variables constant, and with one exception (iodophors), the more concentrated the disinfectant, the greater its efficacy and the shorter the time necessary to achieve microbial kill.

4. **Physical and Chemical Factors** – Several physical and chemical factors also influence disinfectant procedures: temperature, pH, relative humidity, and water hardness. For example, the activity of most disinfectants increases as the temperature increases, but some exceptions exist. Furthermore, too great an increase in temperature causes the disinfectant to degrade and weakens its germicidal activity and thus might produce a potential health hazard.

5. **Organic and Inorganic Matter** – Organic matter in the form of serum, blood, pus, or fecal or lubricant material can interfere with the antimicrobial activity of disinfectants in at least two ways. Most commonly, interference occurs by a chemical reaction between the germicide and the organic matter resulting in a complex that is less germicidal or nongermicidal, leaving less of the active germicide available for attacking microorganisms. Chlorine and iodine disinfectants, in particular, are prone to such interaction. Alternatively, organic material can protect microorganisms from attack by acting as a physical barrier.

6. **Duration of Exposure** – Items must be exposed to the germicide for the appropriate minimum contact time. Multiple investigators have demonstrated the effectiveness of low-level disinfectants against vegetative bacteria (e.g., *Listeria*, *E. coli*, *Salmonella*, VRE, MRSA), yeasts (e.g., *Candida*), mycobacteria (e.g., *M. tuberculosis*), and viruses (e.g., poliovirus) at exposure times of 30–60 seconds.

7. **Biofilms** – Microorganisms may be protected from disinfectants by production of thick masses of cells 428 and extracellular materials, or biofilms. Biofilms are microbial communities that are tightly attached to surfaces and cannot be easly removed.

Sterilization describes a process that destroys or eliminates all forms of microbial life and is carried out in health-care facilities by physical or chemical methods. Steam under pressure, dry heat, EtO gas, hydrogen peroxide gas plasma, and liquid chemicals are the principal sterilizing agents used in health-care facilities. Sterilization is intended to convey an absolute meaning; unfortunately, however, some health professionals and the technical and commercial literature refer to "disin-

fection" as "sterilization" and items as "partially sterile." When chemicals are used to destroy all forms of microbiologic life, they can be called chemical sterilants. These same germicides used for shorter exposure periods also can be part of the disinfection process (i.e., high-level disinfection).

There are 2 phases of sterilization:

1. *Pre-sterilization* – removal of foreign material (e.g., soil, and organic material) from objects and is normally accomplished using water with detergents or enzymatic products. Once items are cleaned, dried, and inspected, those requiring sterilization must be wrapped or placed in rigid containers and should be arranged in instrument trays/baskets according to the guidelines provided by professional organizations.

2. *Sterlization* – has to pass all things that has contact with injuries, blood and medicinal preparations, and medical devices.

Cleaning of medical devices before sterilization

Process	Regime		Equipment used
	temperature	exposure, min	
Rinse under running water	–	0,5	Lavatory bath
Full immersing the article in the washing solution (detergents)	50	15	Lavatory bath
Washing each item using pads or brush	–	0,5	Lavatory bath
Rinse under running water	–	10	
Rinse in distillate water	–	0,5	
Drying with hot air	85	Till complete drying	Drying box

Sterilization of medical devices

Method	Regime		Exposure, min	Medical items
	pressure	temperature		
With vapors	2	132	20	Items from corrosive metal, textile, rubber
	1,1	120	45	Rubber and some polymeric materials

With air		180	60	Items from metal, glass, silicone, rubber.
Chemical. Sol of 6% hydrogen peroxide		18	350	Items from polymeric material, glass, anticorrosive metal.
Dezoxan –1 – sol of 1%		18	45	

PRACTICAL ASSIGNMENTS

1. Prepare solution of 3 liters with concentration of 2% of lime chloride.
2. Prepare 10 liters basic solution of lime chloride of 20% with concentration of active chlorine in it of 20%.
3. Prepare 3 l of basic solution of lime chloride with 30% active chlorine.
4. In a hospital controlling the working solution of 1% lime chloride was demonstrated that it contains 0,05% of active chlorine. Appreciate the quality of disinfectants.
5. After 5 days „Dysentery" ward will be turn into „Hepatitis A" ward. At the moment there are 3 rooms ($60m^3$) with 7 patients. Total surface of all rooms, including WC, is $100m^2$. What kind of disinfection is necessary to perform? When? Name the preparations and equipment used for disinfection.
6. Organize the terminal disinfection in focus of endemic typhus. In focus there are 2 persons with louses.
7. Perform current disinfection in focus of dysentery. Indicate who is responsible for it. What has to be disinfected? Type of disinfection, preparations and its concentration.

QUIZ QUESTIONS

1. How is performed pre-sterilization stage of medical and surgical items?
2. What kind of sterilization regime of medical items exists?
3. What preparations are used for sterilization?

EPIDEMIOLOGICAL IMPORTANCE OF VECTORS OF THE PATHOGEN AGENTS. INSECTICIDES AND REPELLENTS. METHODS OF USING. DESINSECTION AND ITS ORGANIZATION.

Introduction

Basic measure that assesses the effectiveness of the fight against communicable diseases is destroying vectors of causative agents of these infections. From the ecological and biological features point of view of each vector, their control may be done only by knowing these features and specific methods of disinfection.

Goal and objectives of the study – the goal of this issue is to introduce the student to some elementary ideas of disinsection methods. To develop knowledge about the biological and ecological peculiarities of vectors and methods used for destroying them.

Lesson plan

1. Determination of initial level of knowledge.
2. Solving and discussion on practical assignments.
3. Discussion and determination of epidemiological importance of different vectors.
4. Discussion on combating measures of vectors.

Material needed:

The study is organized at the Epidemiology department. Samples of disinsectants. Tools for disinsection. Figures.

Student must know

1. Role and place of disinsection in the system of anti-epidemic measures.
2. Biologic-ecological and epidemiological characteristics of louses.
3. Biologic-ecological and epidemiological characteristics of fleas.
4. Biologic-ecological and epidemiological characteristics of mosquitoes.
5. Biologic-ecological and epidemiological characteristics of ticks.
6. Biologic-ecological and epidemiological characteristics of flies.

7. Disinsection.
   a) Prophylactic disinsection.
   b) Extermination disinsection.
8. Insecticides.
9. Mechanism of action of insecticides.
10. Repellents.
11. Extermination methods of louses.
12. Extermination methods of mosquitoes.
13. Extermination methods of flies.
14. Extermination methods of ticks.
15. Tools and means used for disinsection.

INFORMATIVE MATERIAL

Pathogens of the numerous groups of numerous communicable diseases made their transition from a biological host to another only by live vectors. At this point the arthropods body is just external environment, agent in it multiply, mature, or move to another phase of its metamorphosis.

From the biological and ecological features point of each vector alive, prevention and control measures communicable diseases are possible only by knowing those features and specific methods of disinsection.

Epidemiological importance of arthropods

TICKS – are small arachnids in the order **Ixodida**. Along with mites, they constitute the subclass Acarina. Ticks are ectoparasites (external parasites), living by hematophagy on the blood of mammals, birds, and sometimes reptiles and amphibians. Ticks are vectors of a number of diseases, including Lyme disease, Q fever (rare; more commonly transmitted by infected excreta). Tick species are widely distributed around the world. However, they tend to flourish more in countries with warm, humid climates, because they require a certain amount of moisture in the air in order to undergo metamorphosis, and because low temperatures inhibit their development from egg to larva. For an ecosystem to support ticks, it must satisfy two requirements: there must be a high enough population density of host species in the area, and there must be high enough humidity for ticks to remain hydrated. Due to their role in transmitting Lyme disease, ixodid ticks, particularly *I. scapularis*, have been studied using geographic information systems, in order to develop pre-

dictive models for ideal tick habitats. According to these studies, it was determined that certain features of a given micro-climate – such as sandy soil, hardwood trees, rivers, and the presence of deer – are good predictors of dense tick populations.

Both ixodid and argasid ticks undergo three primary stages of development: larval, nymphal, and adult. Ixodid ticks require three hosts, and their life cycle takes at least one year to complete. Up to 3,000 eggs are laid on the ground by an adult female tick. When larvae emerge, they feed primarily on small mammals and birds. After feeding, they detach from their host and molt to nymphs on the ground, which then feed on larger hosts and molt to adults. Female adults attach to larger hosts, feed, and lay eggs, while males feed very little and occupy larger hosts primarily for mating.

Argasid ticks, unlike ixodid ticks, may go through several nymphal stages, requiring a meal of blood each time. Their lifecycle ranges from months to years. The adult female argasid tick can lay anywhere from a few hundred to over a thousand eggs over the course of her lifetime. Larvae feed very quickly and detach to molt to nymphs. Nymphs may go through as many as seven instars, each requiring a blood meal. Both male and female adults blood-feed, and they mate off the host. During feeding, any excess fluid is excreted by the coxal glands, a process which is unique to argasid ticks.

MOSQUITOES are a family of small, midge-like flies, the *Culicidae*. Although a few species are harmless or even useful, most cause a nuisance by sucking blood from vertebrates, including humans. Several of the most harmful human and livestock diseases are transmitted by mosquitoes during feeding. Accordingly, some authorities argue that mosquitoes are the most dangerous animals on earth. Epidemiological importance has mosquitoes from Anopheles, Culex and Aedes species, vectors of malaria, yellow fever, Dengue fever, tularemia, etc.

Like all flies, mosquitoes go through four stages in their life cycle: egg, larva, pupa, and adult or imago. In most species, adult females lay their eggs in standing water; some lay eggs near the water's edge; others attach their eggs to aquatic plants. Each species selects the situation of the water into which it lays its eggs and does so according to its own ecological adaptations. Some are generalists and are not very fussy. Some breed in lakes, some in temporary puddles. Some breed in mar-

shes, some in salt-marshes. Among those that breed in salt water, some are equally at home in fresh and salt water up to about one third the concentration of seawater, whereas others must acclimatize themselves to the saltiness. Such differences are important because certain ecological preferences keep mosquitoes away from most humans, whereas other preferences bring them right into houses at night. The first three stages – egg, larva and pupa – are largely aquatic. These stages typically last 5–14 days, depending on the species and the ambient temperature, but there are important exceptions. Mosquitoes living in regions where some seasons are freezing or waterless spend part of the year in diapauses; they delay their development, typically for months, and carry on with life only when there is enough water or warmth for their needs. The adult mosquito emerges from the mature pupa as it floats at the water surface. Bloodsucking species, depending on type, gender, and weather conditions, can live as adults from as little as a week to as long as several months.

Methods of vector extermination

1. Mechanical:
   - cleaning, shaking out, cleaning with a vacuum cleaner the living spaces and objects;
   - using traps;
   - using sticky paper.
2. Physical – using high temperature (vapors, boiling)
3. Chemical – using chemical substances toxic for vectors

Measures of lice extermination

1. Individual hygiene and cleaning up the rooms.
2. Hygiene surveillance of crowded places (train stations, campuses, hotels, etc), and to keep hygiene regime in these places.
3. Correct organization of saunas, laundries, barbers.

Extermination of lice includes physical methods by boiling the linen body and bed, ironing, disinsection in ovens, and mechanical methods of removing from the body, linen body and bed.

Chemical method includes extermination by insecticides.

For the body lice extermination is necessary to wash with hot water using soaps with insecticides. Can be used – pyrethrum, carbophos, nitifor, anti-pediculosis shampoo (anti-P), veda.

DISINSECTION – is a set of measures of combating the vectors of the infectious diseases pathogenic agents.

There are 2 groups of disinsection: prophylactic and extermination. The goal of prophylactic measures is to create unfavorable conditions for existing and multiplication of arthropods, preventing there entrance in hoses and human protection. In this group can be included: creation of unfavorable conditions for the reproduction and development of vectors, protecting living settings, using the individual protection means, nets, repellents. From the number of these measures must be recorded in the first sanitation and maintaining cleanliness of locations, garbage collection, systematic removal of waste, recovery and the recent growing territories of individual human protection against attacks arthropods.

Extermination measures are oriented to liquidate arthropods at the all stages of development and in all living places (multiplication places, on the environment objects, etc). There are:

1. Mechanical:
   - cleaning, shaking out, cleaning with a vacuum cleaner the living spaces and objects;
   - using traps;
   - using sticky paper.
2. Physical – using high temperature (vapors, boiling)
3. Chemical – using chemical substances toxic for vectors

Chemical substances that kill insects are called **insecticeds**. In case if it is used for ticks killing – **acaricides**, for larval distruction – **larvicides**, for eggs distruction – **ovicides.** At the same time there is one group of substances that not allow insects to aproch, just to scare them – **repellents**.

Request for insecticides are: high toxicity for arthropods, and low toxicity for human and animals. It is very important length of action time of the substances.

Classification of insecticides depending on the way of penetrating into the vectors' organism:

– ***contact insecticides*** – organic compounds of chlorine (DDT, hexachlorcyclohexane); organic compounds of phosphor –(dihlophos, carbophos, metaphos, trihlophos)

– ***insecticides*** that penetrate via ***respiratory*** ways (fumigants) – sulphurous anhydride, brome methyl, components of cyanic acid etc.

– ***intestinal insecticides*** - boric acid

Hexachlorcyclohexan. White or yellowishsolid flakes or powder persistent,musty odour, insoluble in water, soluble in chloroform, ethanol, ether. Prezents some characteristics:

- Hazardous combustion/products of combustion: poisonous gases are produced when solid is heated or when solution burns.
- When heated to decomposition, emits fumes of chlorides, hydrogen chloride and phosgene
- Stability: stable to light, heat, air, carbon dioxide and strong acids with the exception of the *beta*-isomer, susceptible to dehydrochlorination by alkali at ordinary temperature
- Reactivity: No reaction with water or common materials. Stable during transport. Potentially violent reaction with dimethylformamide in presence of iron, also with carbon tetrachloride.
- Corrosiveness: no data for mixed isomers. Isomer gamma is corrosive to metals
- Dust/vapor hazard: when heated to decomposition, it emits toxic fumes of chloride, hydrogen chloride and phosgene
- Environmental risks, including water pollution and guidance on safe disposal: HCH become partially adsorbed and adsorbed to river bottom sediments. It has a high potential of concentration in food chain.

Chlorophos – substance soluble in water, with unstable odor. It contributes to corrosive effect of metals. The activity is increased at the same time with temperature increasing. Chlorophos acts by contact and intestine, leading to paralyzing action which starts after 5–8 min of contact. It is used as solution with concentration of 0,2–0,5% for treating surface in combating of different insects species (fleas, flies, etc.).

Dichlofos – transparent liquid, soluble in water till 1 %. Can be applied by aerosols and is useful against flies, mosquitoes, etc.

Carbofos – oil liquid, little soluble in water, is effective against beetles, bedbugs, mosquitoes, louses. Has ovicides and larvicides action against flies and louses. It is used as 0,3-3% concentration.

PRACTICAL ASSIGNMENTS

1. Determine biologic-ecological and epidemiological peculiarities for each vector: mosquitoes, ticks, fleas, lice, and flies according to the model.

Vector species	area	Host-animals	How often it is feeding	Life style	Infectious diseases transmitted

2. Determine epidemiological peculiarities of arthropods for each type of species – mosquitoes, ticks, fleas, lice, and flies:

Vector species	Causative agent transmitted	Mode of transmission	Life cycle of causative agent into vectors body	Extermination methods		
				physical	chemical	biological

3. Give the characteristics of insecticides proposed by the teacher according to the scheme:

Insecticides	Duration of action, days	Mechanism of action	Lethal dose	Is toxic for domestic animals and human

4. Give pathogenic agents, which are transmitted by vectors:
   1) Mosquitoes:_____
      - Anopheles_____
      - Culex_____
      - Aedes_____
   2) Tics:_____
   3) Lice:_____
   4) Fleas:_____

5. Center of Public Health received information about 3 school pupils with lice. What measures has to be undertaken to combat pediculosis? Give the list of substances used in this case and its concentration.
6. In July, examining a group of persons that came back from Africa, were detected 2 carriers of malaria. There are numerous mosquitoes. What measures are necessary to perform to stop it spreading?

QUIZ QUESTIONS?

1. Alive vectors role in species maintaining of different pathogen agents.
2. Epidemiological importance of lice.
3. Transmission mechanism in endemic typhus.
4. Epidemiological importance of mosquitoes.
5. Mechanism of contamination in Malaria.
6. Epidemiological importance of fleas.
7. Mechanism of contamination in Plague.
8. Epidemiological importance of ticks.
9. Mechanism of contamination in tick-encephalitis.
10. Epidemiological importance of flies and its role in intestinal infections spreading.
11. Extermination measures of insects.
12. Classification of insecticides.

EPIDEMIOLOGICAL IMPORTANCE OF ANIMALS. RODENTICIDES AND USING METHODS. ORGANIZATION OF DERATIZATION.

Introduction

Natural living environment of the main pathogens in zooanthroponosis presents animals. Therefore sources of infection for humans are mammals, various species of birds, and in some cases reptiles, amphibians, and fish. Among the animals a special epidemiological importance has rodents.

In the system of combating measures of zooanthroponosis (especially for natural hotbeds) rodent destruction is the most important measure.

Goal of the study

The goal of this study is to improve the student's knowledge about ecological and biological features of animals with epidemiological importance and organization and methods of deratization and raticides using.

Lesson plan

1. Determination if initial knowledge.
2. Discussion on deratization work.
3. Discussion on practical assignments.
4. Discussion on deratization methods and its organization in *localities and outdoors.*

Material needs

The study is organized at the Epidemiology department. Will be used samples of raticides substances, deratization means and devices.

Student must know

1. Biological peculiarities of rodents.
2. Importance of deratization in the system of anti-epidemic measures.
3. Prophylactic and extermination methods used in rodents combating.
4. Extermination methods of rodents (mechanical, chemical, biological).
5. Deratization in localities.
6. Quality control of deratization.

INFORMATIVE MATERIAL

Deratization – involves a set of measures and means of combating the rodents that have epidemiological importance, and bring economic damage in various fields of national economy.

Measurements made for deratization are: prophylactic and extermination. Preventive measures are technical means of reducing the access of rodents to different objects, systematic disposal of solid waste, agrotechnical measures. In this context, may be used chemical substances with repellent effect (albihtol, oil shale, etc.). Outdoors have agro-technical measures: deep plowing, harvesting, timely harvest, destruction of weeds in fields and orchards, straw disposal on fields etc.

Extermination measures are for the destruction of synanthrope rodents in all their places of living and are divided into: mechanical, chemical and biological. In practice it is advisable to combine all measures of extermination.

Mechanical method of extermination of rodents is to capture or destroy those using different grippers. Currently this method is used in combination with chemical and biological methods. With less effectiveness, this method is used alone when chemical and biological methods can bring unwanted consequences (preschool, curative and preventive, power) and where the caught devices are used to determine the number of rodents on given territory.

Depending on the construction of catch devices rodents can be killed mechanically (traps) or caught alive (pots, race) and then destroyed.

Chemical method is – poisoning rodents with chemicals chosen especially for this purpose (raticides or rodenticides).

Raticides used in three ways:

a) using the food baits by mixing raticides with a food attractive to rodents or with one that is the staple food in their ration;
b) processing the water – by poisoning of usually drinking water sources of the rodents;
c) using toxic volatile toxic substances – spraying holes, passages, paths frequented by rodents and other objects (trash cans, waste deposits, etc.).

Chemical method when it is used correctly can be performed in closed and open territory, in towns and fields and guarantee high efficiency and stable.

Substances allowed to be used Ministry of Health as raticides quote the following: ratindan (difenacină in powder), zoocumarine, zinc phosphide, tiosemicarbaside, phtoracetamide, monofluorin, monophtorine, ftoracetamide, sliftor.

Ratindan is yellow crystals insoluble in water. The active substance is difenacine. The preparation is stable, has cumulative properties. It is part of anticoagulants. It is less dangerous for domestic animals. It is made in the form of powder difenacine 1:200 compared with starch or talc. Death occurs after eating rodent bait, over 5–8 days. Single lethal dose for rats is 6–8 mg, for mice – 4 mg. Ratindane not recommended for children and curative institutions.

Zoocumarine – anticoagulant, hay-scented powder, insoluble in water. Altering blood vessel walls, cause leakage of blood and therefore die rodents.

It is toxic to pets and humans only in high doses. Death occurs in rodents after consuming food bait over 8th days. Single lethal dose for rats is 12 mg, and if it is consumed with food during five days – of 1mg/kg.

Zinc phosphide – toxic action of this preparation is based on the decomposition of zinc phosphide under the action of hydrochloric acid from the stomach and is not recommended to use for food bait where general composition creates an acidic environment very quickly (bread, porridge), as the acid formed in result remove the hydrogen phosphoric acid.

For food bait may be used only dry preparation. Zinc phosphide has rapidly action, is toxic to humans. Lethal dose for rats is 15-30 mg, for mice is 3–5 mg.

Monophtorine – white or pink crystals odorless. It is stable in storage, soluble in alcohol, acetone, less in hot water. It is used in food bait like grains, with 1% monophtorine for outdoors deratization with expense of 1kg per hectare.

PRACTICAL ASSIGNMENTS

1. List the zooanthroponosis sources from xenantrope group.
2. Give the ecologic-epidemiological characteristics of rodents – source of pathogenic agents and extermination methods according to the table.

Rodents species	Areal	Source of what kind of infection is?	Combating methods		Raticides
			prophylactic	extermination	

3. Give the characteristics of raticides according to the table:

Preparation	Duration of action, days	Mechanism of action	Lethal dose	Mode of using

4. On which industry is prohibited using of the zinc phosphide?
5. Can be used monophtorine for deratization in kindergarten?

QUIZ QUESTIONS

1. Epidemiological importance of animals as source of infection.
2. Organization of deratization in localities.
3. Deratization peculiarities in kindergarten, farm, etc.
4. Organization of deratization outdoors.
5. Classification of rodenticides.
6. Quality control of deratization.

REFERENCES

1. Association of peri-Operative Registered Nurses. Recommended practices for high-level disinfection. AORN J. 2005; 81: 402–12.
2. Centers for Disease Control. Guidelines for Environmental Infection Control in Health-Care Facilities, 2003. MMWR 2003;52 (No. RR-10) : 1–44.
3. Epidemiologie. Chishinau 1998
4. Favero MS, Bond WW. Chemical disinfection of medical and surgical materials. In: Block SS, ed. Disinfection, sterilization, and preservation. Philadelphia: Lippincott Williams & Wilkins, 2001: 881–917.
5. Kohn WG, Collins AS, Cleveland JL, Harte JA, Eklund KJ, Malvitz DM. Guidelines for infection control in dental health-care settings-2003. MMWR 2003;52 (no. RR-17):1–67.
6. William A. Rutala, Ph.D., M.P.H.1,2, David J. Weber, M.D., M.P.H. 1,2, and the Healthcare Infection Control Practices Advisory Committee (HICPAC)3 1Hospital Epidemiology Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008;